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## BOOK NOTICES.

**La Montagne Pelée et ses Éruptions, par A. Lacroix**, Membre de l'Institut, etc. 4to. pp. xxii, 662, pl. 31, text figs. 238. Masson & Cie., Paris, 1904.

This magnificent volume comprises the results of what is probably the most painstaking and thorough investigation of a single series of volcanic eruptions ever undertaken, and is the work of a master of his science. Immediately after the occurrence of the great eruption of Mt. Pelé, May 8, 1902, by which St. Pierre, Martinique, was laid waste and its inhabitants destroyed, the author was sent to the island by the Ministers of Public Instruction and The Colonies as the head of two successive Commissions\* chosen by the Paris Academy of Sciences for the purpose of studying all the phenomena attending the eruptions. Lacroix himself devoted seven months to residence in Martinique, establishing one fully-equipped observatory and a second subordinate observing station, and organizing a Commission which still keeps constant watch upon the volcano. The observatory of Morne des Cadets was built in October, 1903, and was provided with two seismographs, and ample apparatus for meteorologic and photographic work and for making angular observations for determinations of altitude.

The report is divided into three sections: The physics of the globe as illustrated by the phenomena observed by the author on Martinique, Saint Vincent, and Guadeloupe; a chemical and mineralogical study of the products of the eruptions of 1902-1903, supplemented by a comparative study of the older rocks of Martinique and the rocks of other islands of the Lesser Antilles; a study of the minerals and rocks produced during the conflagration of St. Pierre.

The first section fills more than three-fourths of the book with a wealth of observations, fortified with profuse and excellent illustrations, which must ever be the storehouse of data regarding this remarkable series of eruptions. The list of topics considered, as given in the table of contents, is an indication of the breadth of view entertained by the author and the thoroughness with which he has treated every phase of a great subject. The photographs used for the illustrations were taken, almost without exception, by the author himself or by Mme. Lacroix, who accompanied him on both his expeditions to the islands.

Lacroix considers the most important features of the eruptions to have been the formation of the vast dome and spine which filled the old crater of Mt. Pelé and rose far above the former summit of the mountain, and the frequently-recurring exploding clouds of dust-laden steam, his "nuées ardentes."

The beginning of the rise of the "spine" above the top of the cone of eruption in October, 1902, was witnessed by Lacroix, and he watched its growth and variation constantly from that time till about the middle of March, 1903, when it had nearly attained its maximum development of 1,617 meters (5,304 feet) above tide. He was the first to recognize the fact that the new cone

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\* The members of the first commission sent out were: A. Lacroix, Rollet de l'Isle, and J. Giraud.

The second commission consisted of Professor Lacroix alone, but he was joined in March, 1903, by M. Giraud, who remained in charge of the work after Lacroix's return to France.

The chief assistants at the observatories have been Capt. Perney, Ensign Le Cerf, and Adjutant Guinoiseau.

was not primarily of fragmental constitution, but that it was formed mainly of practically solid rock. He holds that the molten but highly viscous lava on reaching the surface of the earth welled out of the conduit of the crater in cumulous form and quickly became covered with a solid crust, which protected the pasty interior from a too rapid loss of heat and complete solidification. The crust became fissured through progressive cooling and consequent contraction and through continued pressure from within. This permitted the further exudation of pasty lava and the construction of a homogeneous rock mass with abrupt, deeply-fissured exterior. The extrusion of the great spine is compared to the production of a metal rod through a draw-plate, and attention is called to the repeated formation of many similar but more ephemeral needles during seasons of marked activity. He says that these extrusions were caused by the localization of the eruptive force within limited areas and the consequent rupture of the new crust. The formation of this dome and its surrounding spine is declared to be the most remarkable feature of any recorded volcanic eruption, and Lacroix holds that it explains the origin of many abrupt rock masses in regions of extinct volcanic activity which have been described as the cores or "plugs" of dissected volcanoes.

The "nuées ardentes" were the destructive agent of the volcano, and they furnished geologists with another novel feature of vulcanism. The theory advanced to account for them considers the clouds as the result of explosions from the flanks of the cone at Pelé and from the bottom of an open crater at Saint Vincent. In the case of feeble eruptions gravity exercised a predominating influence on the advance of the clouds down the mountain side, but with the heavy paroxysms the greater rapidity of motion was due to the initial accumulated force of projection combined with gravity acting in the same direction.

Among other important new ideas added to our knowledge of vulcanism by these eruptions may be mentioned the occurrence in the cone of a rock with a matrix rich in crystals of quartz formed during periods of very slow extrusion; the establishment of relationships among all the rocks of the Lesser Antilles, showing that they form a true petrographic province, the new rocks of Saint Vincent, for example, having their counterparts in the older eruptions of Martinique; the formation in the enormously thick ash-beds of secondary fumaroles—*i. e.*, fumaroles without connection with a deep-seated source of heat; the transportation by the "nuées ardentes" of blocks of lava of enormous size along the sides of the mountain without reference to the topography thereof.

Lacroix concludes that sometimes the conditions under which an eruption occurs have more effect than the chemical composition of the magma upon the accompanying phenomena. The eruptions of Saint Vincent, where the lava is the more basic, were purely explosive, while those of the more acid lava at Pelé were not simply explosive but they also resulted in the formation of a great cone out of fresh lava which was too viscous when extruded to make a stream and flow down the mountain side.

Lacroix lays stress upon the fact that the effects of heat observed in the ruins of the city of St. Pierre were due, not to the temperature of the swiftly-passing cloud, but to the general conflagration started by that cloud. He says that the burning of St. Pierre would not have possessed a factor of value to the history of eruptive rocks if the city had not been constructed of volcanic materials. As it was, however, many interesting facts were brought out by the study of the walls and the objects which were more or less melted in the

burning buildings, producing secondary "lavas" and products of re-crystallization.

The final estimate of the number of persons killed by the eruptions or who died of their wounds is about 28,000 as a maximum for St. Pierre and vicinity May 8, and 1,000 more for Morne Rouge and Ajoupa-Bouillon August 30, 1902. Lacroix discusses all the causes of death which have been suggested, and concludes that the majority of fatalities were due to asphyxiation consequent upon the inhalation of hot dust, steam, and hot air. He does not consider it probable that poisonous sulphur or carbon gases played any important rôle in the destruction of life, and he likewise rejects lightning as having been a great destructive agent at St. Pierre.

Lacroix accepts as true the report of the survival of at least two persons, the famous prisoner and a shoemaker, who were in the city during the eruption. He also cites the cases of persons in houses upon the bluffs overlooking the city and of those upon the ships who survived the eruption, and contends that many lives would have been saved had the houses of St. Pierre been so constructed as to allow of complete closing or had there been cellars beneath them to which the occupants might have resorted. This conclusion is confirmed by reference to the salvation of many persons in heavy stone buildings within the zone of greatest devastation at St. Vincent.

Lacroix recognizes the necessity of an initial explosion to assist the action of gravitation in the advance of the "nuées ardentes" from the crater, and he considers the explosive expanding power of steam suddenly liberated at the probable issuing temperature of 1,200°C. as being ample to account for all the observed phenomena assigned to the action of the destructive blast. He says: "For my part, I do not understand this blast unless there were an initial projection, the direction of which was determined by that of the opening in the flank of the growing dome opposite the V-shaped breach. The force of this initial projection was sufficient to prevent the exploding cloud from being restricted to a southwesterly direction only through the great cleft."

The lava of the eruption is a hypersthene-andesite, which occurs in four types distinguished from one another by their structure and their mineralogical composition. The chemical composition remains the same throughout. The classification into types depends upon the character of the ground-mass. Type I is solidly glassy (obsidian); type II is porously glassy (pumiceous); types III and IV have a cryptocrystalline base, III being non-quartziferous, and IV being rich in quartz. The phenocrysts (porphyritic crystals) of the lava are, in descending order of importance, plagioclase, feldspars, hypersthene, titanomagnetite, olivine, augite, hornblende, ilmenite, and apatite.

The main portion of the dome is considered to be composed of lava of types I, II, and III, while the spine probably consisted of type IV. The "nuées ardentes" of November, 1902, occurring after some weeks of comparative quiet, distributed material of type III, but the continually increasing activity of the succeeding weeks and months discharged dust and lapilli of type I. The eruptions of July 9, August 30, and November 28, 1902, were characterized by the ejection of vast quantities of angular pumice of type II, but it is not to be supposed that any of the great eruptions furnished lava of only one type. The breadcrust bombs which were thrown out in a thoroughly pasty condition show andesite of type I in the crust and pumice (type II) in the interior. The angular bombs which were ejected in a semi-solid condition show a tendency toward type III.

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